National Cooperative Dairy Herd Improvement Program

RECORD BOOK

A plan for every size herd

STANDARD DHIA · OWNER SAMPLER · WEIGH-A-DAY-A-MONTH

AGRICULTURAL RESEARCH SERVICE, U. S. DEPARTMENT OF AGRICULTURE

Dairy-Herd-Improvement Letter

ARS-44-202
(Vol. 44, No. 2)

April 1968

INTRODUCTION

Included in this Dairy Herd Improvement Letter are two articles that explain the methodology and interpretation of USDA-DHIA Sire Summaries. A third article examines the distribution of USDA Sire Summaries on bulls active in artificial insemination (AI) in 1967 and what these data mean to dairymen using AI.

NOTES AND CONCEPTS USED IN USDA SIRE SUMMARY PROCEDURES

by R. D. Plowman, Chief
Dairy Cattle Research Branch, USDA
Beltsville, Maryland

In 1962, USDA adopted a method of daughter-herdmate comparisons for summarizing the progeny performance of sires. This decision to change from daughter-dam comparisons was made because research results had suggested that sire summaries could be more accurate when expressed as differences from herdmates. The daughter-dam comparison was a good method provided that certain assumptions could be met. These assumptions were as follows:

1. Same environmental treatment for both daughters and dams.

2. Future mates of bull similar to dams of original daughters.

Issued August 1968

3. Same environment for future daughters as for first daughters.

These assumptions are difficult to achieve. Too often, the large increase in performance of daughters over that of dams and attributed to the sire was really due to the better environment provided to the daughters by the owner or herdsman. Even if the assumptions were met, the best a daughter-dam comparison could tell us was how a particular bull did when mated to a particular group of cows.

We want a sire summary to tell us what to expect of future daughters based on those already in production. A study completed at Cornell University evaluated different methods of proving sires. This study related initial summaries to summaries made at a later date and considered several methods of evaluation. In other words, it determined the future performance of a bull based on his present daughters. Table 1 gives the results of this study. This table clearly shows that the USDA AI herdmate method of estimating future performance of a sire's daughters is more accurate than the other methods considered.

The herdmate comparison also provides for a method of making judgments among bulls. Each daughter of a sire is compared with other cows in the same herd that freshened at approximately the same time. Since these other cows or herdmates have sires, we are essentially comparing this bull with sires of the herdmates.

1. <u>Steps in computing the USDA sire summary</u>

   A. Standardization of records for age effects.

      In order to use records from all cows in a particular herd, it is necessary to standardize records for age. Recent research by USDA has shown that age correction factors vary greatly in magnitude by season of calving, geographical region, and milk and fat yield. These studies indicate that separate factors should be used to correct for these sources of error. Data analysis

showed that the two seasons of November through June and July through October would be 88 percent as effective as using six 2-month seasons. Two-year-olds calving in the summer had factors about 0.03 to 0.06 lower than those of similar age cows calving in the winter season. Thus, if a single set of factors were used, cows calving in the winter season would be underestimated by approximately 300 pounds of milk and cows calving in the summer would be overestimated by the same amount. The evaluation of a bull on the basis of his initial daughters calving in only one season could be biased. Using these seasonal factors should largely eliminate such biases.

Factors developed for milk production were consistently higher by from 0.02 to 0.05 than those for fat production. Thus, separate factors are needed to accurately adjust for each trait.

Age correction factors for cows in the northeastern part of the United States tend to be higher than those for other regions. Increases with age are least in the Midwestern States and intermediate in the Southeast and West. The differences between regions are of about the same magnitude as the differences between seasons.

B. Weighting records for days in milk.

All records of all daughters should be included in sire summaries to prevent selection out of poorer producing daughters. Therefore, all records reported to USDA are used even if a cow has only one month on test. Short or incomplete records, however, are not given as much weight in the summary as completed records are given. Table 2 shows appropriate weights for projecting incomplete records.

C. Computing the "Predicted Difference."

The formula used to compute the Predicted Difference is as follows:

$$\frac{\Sigma w_i h^2}{4 + (\Sigma w_i - 1)\, h^2 + 4\, \frac{\Sigma n_i (n_i - 1)}{N}\, c^2}\ [(\overline{D} - \overline{HM}) + 0.1\ (\overline{HM} - \text{Breed Av.})]$$

Adjustment for number of daughters and records per daughter	Adjustment for distribution of daus. over herds	Environmental correlation	Adjustment for herd environment and number of herdmates	Adjustment for herd genetic level

Where: w_i = Weight given to each cow according to the number of records she has completed

N = Total number of progeny of the bull

n_i = Number of progeny in the i^{th} herd

($N = n_i$ if all progeny are in one herd)

h^2 = Heritability of milk yield from paternal half-sib estimates in nationwide populations

c^2 = Residual correlations among half-sibs in the same herd after they are expressed as deviations from herdmates

$\overline{D}$ = Daughter average

$\overline{HM}$ = Adjusted herdmate average

The first part of this formula is the regression equation used to adjust the actual daughter-herdmate level for the effects of number of daughters, records per daughter, distribution of daughters over herds, and an environmental correlation. The number of herds involved and the distribution of daughters in these herds

are important considerations that contribute to the accuracy and reliability of a sire summary. The information provided by several daughters in one herd is not as valuable as that provided by one daughter in each herd. Some of the reasons for making adjustments for the distribution of daughters across herds and the numbers of herds are as follows:

(1) In any one herd, a bull's progeny are not compared with a cross section or random sample of the progeny of bulls in the population, but only with the progeny of those bulls most recently used in the herd. These bulls may be limited in number and may be above or below the breed average in genetic merit.

(2) All progeny in a single herd, because of their environmental proximity to each other, appear to be more similar than their genetic relationship would indicate. Because they are generally of similar age and were raised and milked together, they are treated more alike than other and older cows in the herd. This is called an environmental correlation (C^2). In addition to strictly environmental similarities, C^2 also includes everything else in the correlation between half-sisters besides the additively genetic part.

(3) Age adjustment factors do not fit each herd exactly and thus daughters in one or a few herds could be either overestimated or underestimated when judged on a mature equivalent (ME) basis.

As the number of records on each cow increases, we are more confident of her true genetic merit.

Thus, a cow with more than one record should receive more weight in a sire summary than a cow with just one record. Table 3 gives the appropriate weights to cows depending on the number of records they have completed. These weights (w_i) are used in computing USDA sire summaries.

The second half of the formula for computing the Predicted Difference is needed to make adjustments for the number of herdmates and for the genetic level of the herd. Studies have shown that the average genetic difference between herd averages is only about 20 percent. (For example, herds that average 15,000 pounds of milk are only expected to be about 200 pounds genetically superior to herds that average 14,000 pounds of milk. The other 800 pounds of milk comes from better feeding and management.) This does not mean that any two specific herds are only 20 percent different, because this could vary to a considerable degree. The average difference, however, is only about 20 percent. In a sire summary we need to give a herd credit for being either above or below breed average. Since a sire contributes one-half of the genetic material, we give him credit for one-half of this genetic difference between herds. Therefore, 10 percent of the difference between the herdmate average and the breed average is added to the actual daughter-herdmate difference.

Some examples of the use of the formula for deriving the Predicted Difference are illustrated by the sire Jewelholm Supreme Cyclone 1341149. He has 15 daughters that average 18,508 pounds of milk. The herdmates average 16,357 pounds of milk. A C^2 of 0.14 and an h^2 of 0.19 are used in the example.

Example 1. Assume all daughters in a single herd with one record per daughter.

$$\frac{15(.19)}{4 + (14)\ .19 + \frac{4(15)(14)}{15}(.14)} [(18{,}508-16{,}357) + 0.1\ (16{,}357-13{,}059)]$$

$$= \frac{2.85}{6.66 + 7.84}\ [2{,}151 + 330]$$

$$= .197\ (2{,}481)$$

Predicted Difference = +489 Repeatability = 19.7%

Example 2. Assume 5 daughters in one herd, 3 in one herd, and 1 each in 7 herds. One record per daughter.

$$\frac{15(.19)}{4 + (14)\ .19 + \frac{4\ [5(4) + 3(2)]}{15}\ (.14)} [(18{,}508-16{,}357) + 0.1\ (16{,}357-13{,}059)]$$

$$= \frac{2.85}{6.66 + .971}\ [2{,}151 + 330]$$

$$= .373\ (2{,}481)$$

Predicted Difference = +928 Repeatability = 37.3%

Example 3. Assume 2 records per daughter, 5 daughters in one herd, and the rest in single herds.

$$\frac{15(1.33).19}{4 + [15(1.33)-1]\ .19 + \frac{4(5)(4)}{15}\ (.14)} [(18{,}508-16{,}357 + 0.1\ (16{,}357-13{,}059)]$$

$$= \frac{3.79}{7.60 + .745}\ [2{,}151 + 330]$$

$$= .454\ (2{,}481)$$

Predicted Difference = +1,126 Repeatability = 45.4%

The gross distinction between sire summaries based on daughters in many herds (AI Summary) and those based on only one or a few herds (Non-AI) is refined and sharpened. There is a growing trend among private dairymen to sample their bulls in many herds. We can cite examples of bulls with daughters in more than 50 herds that are still being called Non-AI. These sires need to be properly recognized depending on the scope of information available on them. Because of popular pedigrees, some AI bulls are initially sampled in a relatively few herds and with a limited number of daughters. These sires also need to be given their proper evaluation. Under these new procedures, distinctions between bulls will be based on the reliability with which their breeding value can be estimated. All records on daughters of a bull will be used regardless of whether they occur in a single herd or many herds. Proper weights will take into consideration the number of daughters, the number of herds, the number of records per daughter, and the distribution of daughters over herds.

2. <u>Repeatability of the sire summary</u>

You will note in the above example that a Repeatability value is attached to each Predicted Difference. This value indicates how sure we are that a bull's future performance in the general population will approximate his calculated breeding value.

The Repeatability value has nothing to do with conception rate or fertility level of a bull. Neither is it a measure of the transmitting ability of a bull for production traits. It is only a measure of the degree to which we expect the Predicted Difference to be repeated on subsequent provings. Repeatability tells us how sure we are of the breeding value estimated, and the Predicted Difference tells us how much genetic gain we can expect to make by using the bull. We stand to make much more genetic gain by using bulls with low Repeatabilities

and high Predicted Differences than by using bulls with 99 percent Repeatabilities and low Predicted Differences.

Repeatability is the regression equation shown in the first half of the formula for computing the Predicted Difference. It is not really a new concept but merely the regression used to adjust the actual daughter-herdmate difference depending on the number and distribution of daughters and herds. It has always been in the formula but has not been pointed out as the Repeatability of the sire summary. Some people have expressed concern that bull proofs change from summary to summary. The accuracy of the estimates of Predicted Difference depends entirely on the scope of information going into the summary. For example, we may compute a Predicted Difference of plus 500 pounds on two sires, one based on 15 daughters and the other based on 500 daughters. The plus 500 pounds is our best estimate of the bulls' genetic ability; however, we are much more confident and have a much more precise estimate of the breeding value for the sire with many daughters. We can readily see in table 4 how the standard deviation of Predicted Differences changes at different Repeatabilities.

It is extremely important for both the user of a bull and his owner to recognize and understand the Repeatability concept. The user of a bull (whether in AI or private ownership) can take much of the gamble out of his breeding program by using those bulls with high Repeatability. Bulls must have daughters, however, before they can have Repeatabilities and, thus, an owner should fully understand those things that contribute to high Repeatabilities so that he can most effectively prove his bull. Table 5 illustrates the changes in Repeatability with different distributions of daughters and herds. Table 6 further illustrates these principles.

3. Percentage of incomplete first lactations

Listed for each sire is a figure representing the percentage of first lactation records that are reported to us as being incomplete. This figure is a reflection

of the number of daughters of a bull that are culled during their first lactation. It also includes those daughters that are sold from the herd for reasons other than culling and those that may have died.

4. Effective daughters per herd

An index called "Effective Daughters" is included for each bull to show the effective distribution of daughters across herds. If his progeny are equally distributed across herds, the index will be the average number of daughters per herd. Deviations of the index from the average number of daughters will indicate that a large percentage of the progeny are in only one or a small proportion of the herds represented. The Predicted Difference and the Repeatability already reflect the effective distribution of the daughters across herds. Table 7 shows an example of the computation of the effective daughters and the formula for its calculation. You will see that the formula is part of the regression equation used to compute the Repeatability.

5. General services to the industry

We plan to compute sire summaries three times a year—in January, May, and September. Immediately after each run is completed, a computer printout on all active AI sires or those with semen available will be sent to the bull studs, breed associations, and the extension dairyman in charge of breeding in each State. A DHIA Form 1202 will be sent to the owner of other sires proven through the State extension dairy specialist or the respective breed association. This will include the calculated summary of the bull plus a listing of his individual daughters and their deviations from herdmates. We will also make this DHIA Form 1202 available for sires in AI that are summarized with less than 100 daughters.

Resummaries generally will be based on the principle that enough new daughters or records are available to increase the accuracy of the summary. Bulls known to be alive or active in AI and those requested by herd owners

other individuals will need lesser amounts of new information to qualify for resummary.

The major updating of historical information will take place at the May sire summary run of each year. The September and January runs will be based primarily on new bulls (no previous summary), bulls that are alive or active in AI, and the bulls on which there is a significant amount of new information. Please note that because of operational limitations, the decision on whether or not to resummarize a bull must be made before it is possible to compute the true Repeatability of the new summary. Thus, resummaries are based on approximations. Experience has shown that these approximations cause resummary of bulls for which there is a significant amount of new information, but avoid the very costly and wasteful resummary of bulls with little or no new data.

The detailed requirements for resummary of bulls are shown in tables 8 and 9.

Any system or method of sire summary is finally evaluated when dairymen apply it to their herds. Such evidence is available on the Beltsville herd and is presented in table 10. Over a period of approximately 12 years starting in 1948, proven sires were selected from those available in artificial breeding studs. These bulls were all initially proven in breeder herds and evaluated on the basis of a daughter-dam comparison. They were subsequently used heavily in AI and thus have a present Predicted Difference with a high Repeatability. Five sires, numbered 1-5 in table 10, even though initially selected because of a substantial increase of daughters over dams, turned out to have minus Predicted Differences. Their 101 daughters at Beltsville averaged 15,523 pounds of milk (2x,305,M.E.). Their average difference from Beltsville herdmates was -838 pounds of milk. Another group of five bulls all had plus Predicted Differences but ranging only from +56 to +485 pounds of milk. Their 90 daughters at Beltsville averaged 16,259 pounds of milk (2x,305,M.E.) and were +87 pounds of milk over herdmates.

The best five bulls (11-15 in table 10) all had Predicted Differences over 500 pounds of milk and their daughters averaged 16,913 pounds of milk (2x,305,M.E.) and were 622 pounds of milk over herdmates. There are no time trends in these data because bulls from each group were distributed equally over the course of the study.

In each group, there is one sire whose daughters in the Beltsville herd do not conform to expectation based on his Predicted Difference. This is due to the sampling nature of inheritance and is not unusual when a sire has only a few daughters in a single herd. Breeding programs are not built on a single sire, however; and genetic progress is determined by using several bulls over a number of years. Table 10 shows a vivid example of what happens in a herd when sires of different genetic merit are used. Bulls with minus Predicted Differences have daughters that produce less milk than their herdmates. Bulls with moderately plus Predicted Differences have daughters whose average milk production is comparable to their herdmates. Daughters of outstanding sires have the highest average milk production and produce more milk than their herdmates. Daughters of the best group of bulls produced 1,390 pounds more milk than daughters of the sires in group one. This difference could be the difference between profit and loss on many farms.

In summary, the primary changes in USDA procedures for summarizing bulls are concerned with properly accounting for the number of herds, the distribution of daughters in herds, and the number of records per daughter. These procedures will utilize all available information and give it proper weight in estimating breeding value of individual bulls. The other information presented, such as the Repeatability of sire summary, percentage of incomplete first records, and number of herds represented, will serve as additional guidelines to be used in interpreting the estimates of breeding value.

TABLE 1.--Relationships among different methods of proving sires 1/

Method of comparison 2/ I	II	Number of bulls	Av. number of daughters per bull Method I	Method II	Repeatability
A	B	65	41	260	0.14
A	C	29	41	59	.01
A	D	36	40	689	.13
B	C	23	209	37	.34
B	D	48	228	774	.49
C	D	37	35	560	.42
D	D		20	1,000	.50
			50	1,000	.71
			100	1,000	.83
			1,000	1,000	.98

1/ These figures are approximations of the data of Meek and Van Vleck (Journal of Dairy Science, Vol. 47, p. 642-645, 1964) and are based on 1 daughter per herd for the USDA comparison.

2/ Comparison made:
A = Non-AI daughter-dam.
B = AI daughter-dam.
C = Non-AI herdmate.
D = USDA AI herdmate.

TABLE 2.--Weights for projecting incomplete records of cows 2 years old and 3 years and older

Age of cows	Months in milk									
	1	2	3	4	5	6	7	8	9	10
2 yrs.old	0.72	0.83	0.88	0.92	0.94	0.96	0.97	0.98	0.99	1.00
3 yrs.old and older	.60	.74	.82	.86	.91	.93	.96	.98	.99	1.00

TABLE 3.--Weights for different number of lactation records

Number of records	Weight
1	1.00
2	1.33
3	1.50
4	1.60
5	1.67
6	1.71

$$w = \frac{NR}{R \quad [1 + (N-1) \ R]}$$

TABLE 4.--Changes in standard deviations of Predicted Differences for milk at different Repeatabilities

Number of daughters	Number of herds	Repeat-ability (Pct.)	Expected standard deviations (Lb.)
5	1	13.6	405
10	10	33.3	356
20	20	50.0	308
70	70	77.8	205
200	200	90.9	132
1,000	1,000	98.0	61

TABLE 5.--Effect of distribution of daughters across herds 1/

Basic data:	Milk lb.	Fat lb.
20 daughters' average	16,594	589
Herdmates' average	14,353	518

Distribution of daus. and herds	Repeatability of sire summary	Predicted Difference	
		Milk	Fat
20 1/	20.9	+489	+5
10, 10 2/	30.0	+705	+7
7, 7, 6 3/	35.2	+824	+8
5, 5, 5, 5	38.6	+904	+9
1, 1, ..., 1	50.0	+1,171	+12

1/ 20 daughters in one herd.
2/ 10 daughters in each of two herds.
3/ 7 daughters in each of two herds and 6 daughters in another herd.

TABLE 6.--Repeatability of sire summary as affected by number of daughters, number of herds, and distribution of daughters among herds

Number of daughters	1 daughter per herd		5 daughters per herd		10 daughters per herd		All daughters in a single herd	
	No. of herds	Repeat-ability (Pct.1/)	No. of herds	Repeat-ability (Pct.1/)	No. of herds	Repeat-ability (Pct.1/)	No. of herds	Repeat-ability (Pct.1/)
5	5	20.0	1	13.6	--	----	1	13.6
10	10	33.3	2	23.9	1	17.7	1	17.7
15	15	42.9	3	32.1	--	----	1	19.7
20	20	50.0	4	38.6	2	30.1	1	20.9
25	25	55.6	5	44.0	--	----	1	21.6
30	30	60.0	6	48.6	3	39.2	1	22.1
40	40	66.7	8	55.7	4	46.3	1	22.9
50	50	71.4	10	61.2	5	51.8	1	23.3
70	70	77.8	14	68.8	7	60.1	1	23.9
100	100	83.3	20	75.9	10	68.3	1	24.3
200	200	90.9	40	86.3	20	81.2	1	24.8

1/ Repeatability of sire summary.

TABLE 7.--Example of computation of "Number of effective daughters per herd"

Effective daughters = $1.0 + \frac{\Sigma n_i(n_i-1)}{N}$

Herd code	No. of daughters (n_i)	(n_i-1)	$\Sigma n_i(n_i-1)$
11-11-0001	16	15	240
16-12-0046	3	2	6
23-59-0087	2	1	2
32-33-9712	1	0	0
55-48-0054	8	7	56
57-25-0014	6	5	30
6 herds 1/	36		334

1/ 36 = N; 334 = $\Sigma n_i\ (n_i-1)$

Effective daughters per herd $= 1.0 + \frac{\Sigma n_i\ (n_i-1)}{N}$

$= 1.0 + \frac{334}{36}$

$= 1.0 + 9.28$

$= 10.28$ or = approximately 10

TABLE 8.--Minimum requirements for resummary of bulls in the May USDA production run

Number of daughters in previous summary	Live bulls (including active AI)	Special requests	Bulls of unknown status that are not requested 1/
No previous summary	10 daughters with herdmates	10 daughters with herdmates	10 daughters with herdmates
10-200	Resummarize 2/	Resummarize 2/	One or more new daughters and 10% increase in number of records No new daughters: If registered in 1960 or later, resummarize if 33% increase in number of records If registered before 1960; resummarize if 100% increase in number of records
201 and up	Resummarize 2/	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or if 50% increase in number of records	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or if 100% increase in number of records

1/ Includes dead bulls and inactive AI bulls.
2/ If the bull still has 10 or more daughters in file with herdmates.

TABLE 9.--Requirements for resummary of bulls in the September and January USDA production runs

Number of daughters in previous summary	Live bulls and special requests (including active AI)	Bulls of unknown status that are not requested 1/
No previous summary	10 daughters with herdmates	10 daughters with herdmates
10-200	Must have new data plus a 10% increase in total number of records since last summary 2/	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or 100% increase in number of records
201-499	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or 50% increase in number of records	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or 100% increase in number of records
500 and up	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or 100% increase in number of records	Enough new daughters for 10% increase in Repeatability if each new daughter is in a different herd, or 100% increase in number of records

1/ Includes dead bulls and inactive AI bulls.
2/ Either a new daughter or a new record since last summary.

TABLE 10.--Performance of sires used in the USDA herd at Beltsville, Maryland

Sire	Predicted Difference	Number of daughters	Average milk production	Difference from herdmates
	Pounds		Pounds	Pounds
1	-649	25	14,590	-1,641
2	-323	16	14,670	-1,358
3	-244	14	16,720	+261
4	-176	14	15,420	-1,111
5	-101	32	16,200	-339
Average	-299	101	15,523	-838
6	+56	22	15,670	+175
7	+132	30	16,160	+61
8	+317	14	15,300	-944
9	+433	8	16,600	+526
10	+485	16	16,550	+616
Average	+284	90	16,259	+87
11	+563	21	16,960	+472
12	+654	8	16,990	+731
13	+957	26	17,700	+1,753
14	+1,077	13	15,900	-58
15	+1,312	14	16,280	+149
Average	+913	82	16,913	+622

APPROXIMATE PROBABILITIES THAT BULLS WITH GIVEN PREDICTED DIFFERENCES AND REPEATABILITIES ARE BREED IMPROVERS

by B. T. McDaniel

Tables 11 and 12 can be used to determine the probabilities that bulls listed in the USDA sire summaries are actually transmitting above breed average production to their daughters. These probabilities are based on the Predicted Difference for milk and its Repeatability. Levels of Predicted Difference in 100-pound increments and selected levels of Repeatability are given in each table. Table 11 gives the probabilities for Ayrshire, Guernsey, and Jersey bulls. Table 12 gives the probabilities for Brown Swiss and Holstein bulls.

As an example of the use of these tables, suppose two Jersey bulls are available: Bull A has +300 Predicted Difference (PD) and 20 percent Repeatability and bull B has +200 PD and 60 percent Repeatability. Table 11 shows that the probability that the bulls will be breed improvers for milk yield is 80 percent for bull A and only 78 percent for bull B. In other words, if 100 bulls have +300 PD and 20 percent Repeatability and 100 bulls have +200 PD and 60 percent Repeatability, we would expect that 80 of the first group and 78 of the second group would be breed improvers. Another important point is that the average of all 100 bulls in the first group is +300 but it is only +200 in the second group.

Dairymen should also remember that in using a series of bulls over a long period of time Predicted Differences primarily determine the genetic improvement such bulls make to their herd. However, the confidence that can be put in any one bull is a function of Repeatability.

If a dairyman is using several bulls in his herd simultaneously, they should be chosen only on Predicted Difference. This is because the true average transmitting ability of all will be near the mean of their Predicted Differences regardless of the Repeatabilities. However, the lower the Repeatability, the more likely that the true transmitting ability will vary from the Predicted Difference. Thus, if he plans to use only one or two bulls, it is important that he consider Repeatability to minimize the probability that the bulls he chooses are poorer than they seem.

TABLE 11.--Approximate probability that an Ayrshire, Jersey, or Guernsey bull 1/ with a given Repeatability and Predicted Difference for milk production has a true genetic merit above breed average

Predicted Difference milk(pounds)	Repeatability 2/												
	15	20	25	30	35	40	45	50	60	70	80	90	95
	Percent												
+1000	99	--	--	--	--	--	--	--	--	--	--	--	--
+900	99	--	--	--	--	--	--	--	--	--	--	--	--
+800	98	99	--	--	--	--	--	--	--	--	--	--	--
+700	97	97	98	98	98	99	--	--	--	--	--	--	--
+600	95	95	96	96	97	97	98	98	99	--	--	--	--
+500	91	92	92	93	94	95	95	96	98	99	--	--	--
+400	86	87	87	88	89	90	91	92	94	97	99	--	--
+300	79	80	81	81	82	83	84	85	88	91	95	99	--
+200	70	71	72	72	73	74	75	76	78	82	87	94	99
+100	60	61	61	61	62	62	63	63	65	67	71	78	87
0	50	50	50	50	50	50	50	50	50	50	50	50	50
-100	39	38	38	38	37	37	36	36	34	32	28	21	12
-200	29	28	27	27	26	25	24	23	21	17	12	5	0
-300	20	19	18	18	17	16	15	14	11	8	4	0	0
-400	13	12	12	11	10	9	8	7	5	2	0	0	0
-500	8	7	7	6	5	4	4	3	1	0	0	0	0
-600	4	4	3	3	2	2	1	1	0	0	0	0	0
-700	2	2	1	1	1	0	0	0	0	0	0	0	0

1/ Assuming the standard deviation among bulls is 400 pounds.

2/ Dashes indicate probability over 99 percent.

TABLE 12.--Approximate probability that a Holstein or Brown Swiss bull 1/ with a given Repeatability and Predicted Difference has a true genetic merit above breed average

Predicted Difference milk(pounds)	Repeatability 2/												
	15	20	25	30	35	40	45	50	60	70	80	90	95
	Percent												
+1000	98	98	98	98	99	--	--	--	--	--	--	--	--
+900	96	97	97	97	98	98	99	--	--	--	--	--	--
+800	94	95	95	96	96	97	97	98	99	--	--	--	--
+700	91	92	93	93	94	95	96	96	98	99	--	--	--
+600	88	89	89	90	91	92	93	94	96	98	99	--	--
+500	84	84	85	86	87	88	89	90	92	95	98	99	--
+400	78	79	80	81	81	82	83	85	87	91	95	99	--
+300	72	73	73	74	75	75	77	78	80	84	89	96	99
+200	65	66	66	66	67	68	68	69	71	74	79	87	95
+100	58	58	58	58	59	59	59	60	61	63	66	71	79
0	50	50	50	50	50	50	50	50	50	50	50	50	50
-100	41	41	41	41	40	40	40	39	38	36	33	28	20
-200	34	33	33	33	32	31	31	30	28	25	20	12	4
-300	27	26	26	25	24	24	22	21	19	15	10	3	0
-400	21	20	19	18	18	17	16	14	12	8	4	0	0
-500	15	15	14	13	12	11	10	9	7	4	1	0	0
-600	11	10	10	9	8	7	6	5	3	1	0	0	0
-700	8	7	6	6	5	4	3	1	0	0	0	0	0

1/ Assuming standard deviation among bulls of 550 pounds.
2/ Dashes indicate probability over 99 percent.

DISTRIBUTION OF ACTIVE AI SIRES SUMMARIZED IN THE JANUARY 1968 USDA-DHIA SIRE SUMMARY BY LEVEL OF PREDICTED DIFFERENCE FOR MILK PRODUCTION OF DAUGHTERS

by F. N. Dickinson, B. T. McDaniel, and A. H. Gardiner

All sires that were in active service as of January 1, 1967, and that were summarized in the January 1968 USDA-DHIA Sire Summary List were categorized separately by breed according to the level of their Predicted Differences (PD) for milk production and the Repeatability of their Predicted Difference. Counts of sires with Repeatability of Predicted Differences of 50 percent or above are shown in table 13; they are categorized by increments of 200 pounds of milk in Predicted Difference. Counts of sires with Repeatability of Predicted Differences of less than 50 percent are shown in table 14, categorized by the same increments. In each table are summarizations, by breed, of averages calculated by weighting all sires of each breed equally, regardless of number of daughters or daughter records.

INTERPRETATION OF DATA

Because of the manner in which Predicted Difference is calculated, a zero Predicted Difference in the tables indicates that a sire has transmitted approximately breed average production to his daughters thus far and will be expected to transmit approximately breed average production to his future progeny. Of course all bulls have some daughters that produce above breed average and some below. But on the average, the daughters of a sire with zero Predicted Difference will be close to breed average. On the average, bulls with negative Predicted Differences will sire daughters that are below breed average in production and bulls with plus Predicted Differences will sire daughters that produce above breed average.

The Repeatability factor is a measure of the confidence or sureness that a sire's Predicted Difference is an exact indication of the level of production that he transmits to his daughters. In other words, the higher the Repeatability of a sire's Predicted Difference, the more certain it is that that sire's Predicted Difference is close to his true transmitting ability for production. If a sire has a large plus Predicted

Difference, +1,000 pounds of milk for instance, and that Predicted Difference has a high Repeatability, let us say 95 percent, the probability is very high that the sire's future daughters will produce, on the average, well above most other cows in the herds in which they are milked. Conversely, a large minus Predicted Difference with a high Repeatability indicates that most of that sire's daughters will produce below the average of the herds in which they are milked. However, because of the adjustments that are made for environmental and genetic effects when calculating Predicted Difference, even proofs with relatively low Repeatability give a fairly reliable indication of whether a sire will transmit above breed average production.

WHAT DO THESE DATA MEAN TO A DAIRYMAN

Dairymen who derive most of their income from the sale of milk should, of course, be using primarily the sires with the high plus Predicted Differences. These tables indicate that the availability of AI sires with plus PD is sufficient in all breeds to fulfill the requirements of the industry for a pool of germ plasm that will assure a steady increase in production in future generations. However, the average Predicted Differences indicate that a great deal more selection for increased production could be practiced. For instance, among the sires with the high Repeatability (table 13) 78 sires in all breeds have Predicted Differences for milk of -400 pounds or below.

The probability that any of these sires actually transmits breed average milk production to his daughters is about 10 percent in Holstein and Brown Swiss and about 4 percent in the other breeds. In both instances an average Repeatability of 65 percent is assumed. The chance that any of these sires will transmit above breed average milk production to his daughters is much smaller. Thus, dairymen using such bulls should understand that they can expect to have the future milk production of their herd lowered from current levels.

Included in this group of 78 sires are 42 bulls with Predicted Differences for milk of -600 pounds or below. Only about 2 percent of the Holstein and Brown Swiss bulls in this

category, and essentially no bulls from the other breeds, can be expected to be actually transmitting breed average milk production to their daughters. In other words, dairymen using these sires should be fully aware that they are almost certainly bringing into their herds genetic material that will lower milk production.

At the same time, this group of sires with Repeatabilities of 50 percent or more (table 13) contains 157 sires with Predicted Differences for milk of +400 pounds or more. The probability that these sires transmit above breed average production to their daughters is about 97 percent in Holstein and Brown Swiss and about 99 percent in the other breeds. In other words, the sires in this group will raise milk production in most herds.

Among the sires with Repeatabilities of less than 50 percent (table 14) 16 sires have Predicted Differences for milk of -400 pounds or below. Assuming an average Repeatability of 30 percent for these sires, the probability that any of them transmits breed average milk production to his daughters is about 18 percent in Holstein and Brown Swiss and about 11 percent in the other breeds. The Predicted Differences of these sires will change somewhat as more daughters complete records; the additional records will make their summaries more accurate (and the Repeatability higher). However, it is fairly certain that most of these sires are actually transmitting below breed average milk production to their daughters. On the other hand, of the sires with below 50 percent Repeatability, 83 have Predicted Differences for milk of +400 pounds or above. The probability of these sires transmitting above breed average milk production to their daughters is approximately 81 percent in Holstein and Brown Swiss and about 88 percent in the other breeds. Again, the Predicted Differences on these sires may change as they produce more daughters and the estimate of their true genetic merit for milk production becomes more accurate. However, the odds are very high that most of these sires are transmitting well above breed average milk production to their daughters.

WHAT THESE DATA MEAN TO THE DAIRY INDUSTRY

What does all this mean to the dairy industry and to individual dairymen? It means that dairymen could increase milk production per cow more rapidly than they are. It means that they could eliminate the use of AI sires that are almost certain to decrease production and lower their income. It means that the AI sire population could and should be composed almost entirely of bulls that would raise production while maintaining or improving other inherited characteristics.

TABLE 13.--Average production of milk and butterfat of daughters of sires in artificial-breeding service with 50% or more Repeatability, grouped according to milk production range of the Predicted Difference

Predicted Difference in milk production—range (Pounds)	Sires	Percentage of sires in group	Daughters with herdmates	Records of daughters	Average production: Daughters Milk	Daughters Butterfat		Herdmates Milk	Herdmates Butterfat		Predicted Diff. Milk	Predicted Diff. Butterfat
	Number		Number	Number	Pounds	%	Pounds	Pounds	%	Pounds	Pounds	Pounds
				AYRSHIRE								
- 200 TO - 399	2	12.5%	246	358	10,861	4.0	439	11,322	4.0	457	-267	-9
- 1 TO - 199	1	6.3%	211	327	10,804	4.2	449	10,983	4.0	442	-115	7
0 TO 199	4	25.0%	142	235	11,006	4.0	440	10,827	4.0	435	115	4
200 TO 399	4	25.0%	1,005	1,596	11,234	4.0	445	10,947	4.0	438	277	7
400 TO 599	4	25.0%	403	637	11,454	3.9	444	10,855	4.0	432	462	9
600 TO 799	1	6.3%	58	103	12,499	3.9	489	11,305	3.9	445	754	27
TOTAL OR AV. BY SIRE UNWEIGHTED	16		2,065	3,256	11,237	4.0	446	10,965	4.0	439	220	6
WEIGHTED BY NUMBER OF DAUGHTERS			2,065	3,256	11,228	4.0	445	10,948	4.0	438	211	6
				GUERNSEY								
- 400 TO - 599	4	4.8%	707	1,151	8,741	4.9	425	9,518	4.8	[illegible]	-543	-17
- 200 TO - 399	9	10.7%	1,306	2,067	9,296	4.8	451	9,768	4.8	465	-294	-7
- 1 TO - 199	11	13.1%	611	1,007	9,271	4.8	442	9,420	4.8	448	-75	-2
0 TO 199	16	19.0%	1,639	3,168	9,666	4.7	458	9,529	4.7	449	118	7
200 TO 399	26	31.0%	4,753	8,468	9,993	4.7	466	9,658	4.7	458	282	8
400 TO 599	10	11.9%	1,395	2,617	10,430	4.7	485	9,815	4.7	466	503	16
600 TO 799	6	7.1%	2,403	3,605	10,711	4.6	492	10,021	4.7	474	689	20
800 TO 999	2	2.4%	388	702	10,562	4.7	499	9,611	4.7	455	872	42
TOTAL OR AV. BY SIRE UNWEIGHTED	84		13,202	22,785	9,819	4.7	463	9,651	4.7	457	172	6
WEIGHTED BY NUMBER OF DAUGHTERS			13,202	22,785	9,823	4.7	463	9,651	4.7	457	259	9
				HOLSTEIN								
-1000 AND BELOW	7	2.0%	930	1,060	12,686	3.9	491	14,271	3.7	525	-1,214	-24
- 800 TO - 999	10	2.9%	2,941	4,295	13,053	3.7	485	14,158	3.6	513	-865	-20
- 600 TO - 799	17	4.9%	2,050	2,714	13,262	3.8	502	14,439	3.7	528	-704	-13
- 400 TO - 599	23	6.7%	4,120	5,549	13,579	3.7	498	14,356	3.6	523	-489	-14
- 200 TO - 399	40	11.6%	11,503	16,353	13,881	3.7	513	14,380	3.6	523	-294	-5
- 1 TO - 199	53	15.4%	16,815	23,289	14,130	3.6	515	14,354	3.6	523	-90	-2
0 TO 199	38	11.0%	7,953	12,076	14,445	3.6	522	14,425	3.6	524	90	2
200 TO 399	46	13.3%	9,962	17,202	14,624	3.6	527	14,336	3.6	522	294	7
400 TO 599	46	13.3%	11,597	16,763	15,018	3.6	540	14,476	3.6	526	502	13
600 TO 799	23	6.7%	4,857	7,264	15,189	3.6	547	14,405	3.6	522	696	22
800 TO 999	23	6.7%	8,659	12,759	15,603	3.6	556	14,645	3.6	534	890	22
1000 AND UP	19	5.5%	4,330	6,105	15,885	3.5	561	14,497	3.7	530	1,203	28
TOTAL OR AV. BY SIRE UNWEIGHTED	345		85,717	125,429	14,446	3.6	525	14,406	3.6	524	123	4
WEIGHTED BY NUMBER OF DAUGHTERS			85,717	125,429	14,466	3.6	525	14,410	3.6	524	160	5
				JERSEY								
- 800 TO - 999	1	1.3%	82	113	7,212	5.3	382	8,357	5.1	425	-877	-32
- 600 TO - 799	5	6.3%	1,043	1,285	7,987	5.3	422	8,916	5.1	452	-634	-19
- 400 TO - 599	1	1.3%	37	42	8,504	5.2	440	9,227	5.1	473	-411	-17
- 200 TO - 399	8	10.1%	977	1,585	8,058	5.1	411	8,508	5.1	430	-292	-12
- 1 TO - 199	15	19.0%	1,839	3,353	8,657	5.1	444	8,814	5.1	452	-85	-3
0 TO 199	13	16.5%	1,616	2,834	8,784	5.2	454	8,714	5.1	445	75	8
200 TO 399	21	26.6%	4,790	7,638	9,383	5.0	469	9,103	5.1	463	265	8
400 TO 599	8	10.1%	1,162	2,344	9,414	5.0	471	8,828	5.1	450	493	18
600 TO 799	4	5.1%	469	866	9,765	5.0	487	8,743	5.2	452	712	25
800 TO 999	2	2.5%	231	484	10,828	4.8	522	9,856	5.1	499	824	22
1000 AND UP	1	1.3%	36	73	10,903	5.2	565	9,318	5.2	489	1,123	55
TOTAL OR AV. BY SIRE UNWEIGHTED	79		12,282	20,617	8,964	5.1	455	8,880	5.1	453	102	5
WEIGHTED BY NUMBER OF DAUGHTERS			12,282	20,617	8,976	5.1	456	8,878	5.1	453	108	5

TABLE 13.--Average production of milk and butterfat of daughters of sires in artificial-breeding service with 50% or more Repeatability, grouped according to milk production range of the Predicted Difference--Continued

Predicted Difference in milk production—range (Pounds)	Sires	Percentage of sires in group	Daughters with herdmates	Records of daughters	Average production: Daughters Milk	Daughters Butterfat		Herdmates Milk	Herdmates Butterfat		Predicted Diff. Milk	Predicted Diff. Butterfat
	Number		Number	Number	Pounds	%	Pounds	Pounds	%	Pounds	Pounds	Pounds
				BROWN SWISS								
- 600 TO - 799	2	6.3%	137	219	10,736	4.1	441	11,768	4.1	478	-659	-23
- 400 TO - 599	8	25.0%	770	1,125	11,235	4.1	465	11,955	4.1	486	-475	-12
- 200 TO - 399	6	18.8%	880	1,572	11,654	4.2	486	12,169	4.1	496	-336	-4
- 1 TO - 199	2	6.3%	145	189	12,301	4.1	510	12,533	4.1	516	-99	
0 TO 199	3	9.4%	846	1,200	12,405	4.0	501	12,304	4.1	500	99	3
200 TO 399	4	12.5%	676	1,183	12,937	4.1	525	12,694	4.1	520	281	7
400 TO 599	1	3.1%	50	58	12,824	4.1	524	12,218	4.2	514	422	[illegible]
600 TO 799	3	9.4%	265	633	13,284	4.0	529	12,274	4.1	503	712	20
800 TO 999	1	3.1%	60	74	14,458	4.0	578	13,381	4.1	553	875	23
1000 AND UP	2	6.3%	130	261	13,488	4.0	534	12,153	4.1	495	1,075	32
TOTAL OR AV. BY SIRE UNWEIGHTED	32		3,959	6,514	12,155	4.1	497	12,240	4.1	500	-10	1
WEIGHTED BY NUMBER OF DAUGHTERS			3,959	6,514	12,165	4.1	497	12,232	4.1	499	-23	1
				M. SHORTHORN								
400 TO 599	1	100.0%	22	42	10,314	3.8	392	9,390	3.8	353	478	20
TOTAL OR AV. BY SIRE UNWEIGHTED	1		22	42	10,314	3.8	392	9,390	3.8	353	478	20
WEIGHTED BY NUMBER OF DAUGHTERS			22	42	10,314	3.8	392	9,390	3.8	353	478	20
				RED DANE								
0 TO 199	2	66.7%	94	151	12,719	3.9	496	12,792	3.9	502	36	1
200 TO 399	1	33.3%	75	152	13,282	3.9	514	12,885	3.9	504	360	10
TOTAL OR AV. BY SIRE UNWEIGHTED	3		169	303	12,906	3.9	502	12,823	3.9	502	144	4
WEIGHTED BY NUMBER OF DAUGHTERS			169	303	12,919	3.9	503	12,826	3.9	502	180	5

TABLE 14.--Average production of milk and butterfat of daughters of sires in artificial-breeding service with 49% or less Repeatability, grouped according to milk production range of the Predicted Difference

Predicted Difference in milk production—range (Pounds)	Sires	Percentage of sires in group	Daughters with herdmates	Records of daughters	Average production: Daughters: Milk	Daughters: Butterfat		Herdmates: Milk	Herdmates: Butterfat		Predicted Diff.: Milk	Predicted Diff.: Butterfat
	Number		Number	Number	Pounds	%	Pounds	Pounds	%	Pounds	Pounds	Pounds
				AYRSHIRE								
1 TO - 199	1	10.0%	7	7	11,877	3.9	466	12,073	4.0	481	-7	-1
0 TO 199	1	10.0%	29	53	11,615	4.1	471	11,404	4.0	453	124	[illegible]
200 TO 399	4	40.0%	54	89	13,269	3.8	498	11,980	3.9	469	314	7
400 TO 599	4	40.0%	70	143	14,258	4.0	568	12,391	4.0	493	518	21
TOTAL OR AV. BY SIRE UNWEIGHTED	10		160	292	13,360	3.9	520	12,096	4.0	478	345	12
WEIGHTED BY NUMBER OF DAUGHTERS			160	292	13,355	3.9	520	12,096	4.0	478	355	13
				GUERNSEY								
- 400 TO - 599	2	3.3%	40	41	9,620	5.2	500	10,992	5.0	545	-458	-14
- 200 TO - 399	2	3.3%	38	46	9,449	4.9	459	10,137	4.6	467	-220	-1
- 1 TO - 199	12	19.7%	284	572	9,976	4.8	477	10,396	4.8	494	-100	-3
0 TO 199	18	29.5%	373	706	10,772	4.8	518	10,546	4.8	506	113	6
200 TO 399	18	29.5%	338	575	11,661	4.8	554	10,838	4.8	519	287	13
400 TO 599	5	8.2%	89	152	12,615	4.7	590	10,371	4.9	505	503	18
600 TO 799	3	4.9%	37	70	14,063	4.4	625	11,557	4.6	536	679	24
800 TO 999	1	1.6%	16	33	13,619	4.3	589	10,540	4.4	464	878	35
TOTAL OR AV. BY SIRE UNWEIGHTED	61		1,215	2,195	11,156	4.8	530	10,639	4.8	508	165	8
WEIGHTED BY NUMBER OF DAUGHTERS			1,215	2,195	11,145	4.8	530	10,631	4.8	508	138	7
				HOLSTEIN								
- 800 TO - 999	1	.5%	29	38	12,193	4.0	492	14,943	3.7	549	-836	-15
- 600 TO - 799	1	.5%	10	10	12,540	4.0	502	14,798	3.7	541	-663	-10
- 400 TO - 599	6	3.2%	127	166	13,292	3.8	504	14,673	3.6	535	-504	-10
- 200 TO - 399	8	4.3%	125	185	13,591	3.7	506	14,648	3.6	532	-319	-8
- 1 TO - 199	33	17.6%	863	1,597	14,728	3.7	539	15,194	3.6	553	-94	-2
0 TO 199	39	20.7%	1,144	2,102	15,227	3.7	557	15,034	3.7	549	116	5
200 TO 399	47	25.0%	1,180	1,971	16,093	3.7	589	15,366	3.7	565	290	10
400 TO 599	27	14.4%	732	1,274	16,784	3.7	614	15,531	3.7	569	475	16
600 TO 799	16	8.5%	391	723	17,384	3.6	627	15,409	3.6	561	705	23
800 TO 999	7	3.7%	167	298	18,336	3.6	651	16,136	3.6	589	896	25
1000 AND UP	3	1.6%	46	59	19,711	3.4	675	15,656	3.6	563	1,167	32
TOTAL OR AV. BY SIRE UNWEIGHTED	188		4,814	8,423	15,788	3.7	577	15,270	3.7	558	223	8
WEIGHTED BY NUMBER OF DAUGHTERS			4,814	8,423	15,793	3.7	577	15,269	3.7	558	226	8
				JERSEY								
- 400 TO - 599	4	6.5%	75	106	7,473	5.2	385	9,002	5.1	457	-463	-20
- 200 TO - 399	2	3.2%	19	21	8,505	5.3	450	9,834	5.0	496	-309	-9
- 1 TO - 199	14	22.6%	283	461	8,975	5.2	463	9,350	5.1	477	-82	-2
0 TO 199	15	24.2%	1,018	1,615	9,777	5.1	497	9,522	5.1	485	107	5
200 TO 399	17	27.4%	493	759	10,492	5.1	538	9,683	5.2	500	280	13
400 TO 599	8	12.9%	222	446	10,916	5.1	562	9,682	5.1	498	470	24
600 TO 799	1	1.6%	9	12	12,306	4.6	564	9,621	5.2	498	696	18
800 TO 999	1	1.6%	15	31	10,325	4.8	499	8,250	5.0	410	943	40
TOTAL OR AV. BY SIRE UNWEIGHTED	62		2,134	3,451	9,799	5.1	501	9,505	5.1	486	131	7
WEIGHTED BY NUMBER OF DAUGHTERS			2,134	3,451	9,853	5.1	504	9,539	5.1	488	144	8

TABLE 14.--Average production of milk and butterfat of daughters of sires in artificial-breeding service with 49% or less Repeatability, grouped according to milk production range of the Predicted Difference--Continued

Predicted Difference in milk production—range (Pounds)	Sires	Percentage of sires in group	Daughters with herdmates	Records of daughters	Average production						Predicted Diff.	
					Daughters			Herdmates				
					Milk	Butterfat		Milk	Butterfat		Milk	Butterfat
	Number		Number	Number	Pounds	%	Pounds	Pounds	%	Pounds	Pounds	Pounds
					BROWN SWISS							
- 600 TO - 799	1	4.0%	38	85	12,272	4.3	523	14,219	4.0	573	-614	-14
- 400 TO - 599	1	4.0%	21	27	10,887	4.0	435	11,912	4.0	479	-465	-19
- 200 TO - 399	2	8.0%	34	34	11,844	4.1	489	12,407	4.1	513	-211	-8
- 1 TO - 199	2	8.0%	15	16	12,999	4.1	532	13,933	4.2	589	-129	-9
0 TO 199	8	32.0%	128	212	13,212	4.2	552	12,829	4.1	529	118	7
200 TO 399	5	20.0%	99	203	14,117	4.0	564	13,082	4.1	537	318	10
400 TO 599	5	20.0%	155	283	13,714	4.0	553	12,236	4.1	500	524	19
600 TO 799	1	4.0%	15	27	14,877	3.9	577	13,635	4.0	550	609	15
TOTAL OR AV. BY SIRE UNWEIGHTED	25		505	887	13,303	4.1	543	12,867	4.1	529	160	6
WEIGHTED BY NUMBER OF DAUGHTERS			505	887	13,351	4.1	545	12,896	4.1	530	188	7
					M. SHORTHORN							
- 200 TO - 399	1	10.0%	5	7	8,277	3.7	305	9,262	3.7	346	-205	-8
- 1 TO - 199	4	40.0%	54	114	9,087	3.7	339	9,603	3.8	362	-113	-4
0 TO 199	4	40.0%	74	150	10,117	3.6	368	9,567	3.7	354	151	5
200 TO 399	1	10.0%	14	18	10,789	3.5	380	9,734	3.7	360	318	6
TOTAL OR AV. BY SIRE UNWEIGHTED	10		147	289	9,588	3.7	351	9,567	3.7	357	27	0
WEIGHTED BY NUMBER OF DAUGHTERS			147	289	9,598	3.7	352	9,571	3.7	357	59	1
					RED DANE							
400 TO 599	1	100.0%	43	106	13,948	3.9	542	12,647	3.9	495	506	18
TOTAL OR AV. BY SIRE UNWEIGHTED	1		43	106	13,948	3.9	542	12,647	3.9	495	506	18
WEIGHTED BY NUMBER OF DAUGHTERS			43	106	13,948	3.9	542	12,647	3.9	495	506	18

UNITED STATES DEPARTMENT OF AGRICULTURE
AGRICULTURAL RESEARCH SERVICE
BELTSVILLE, MARYLAND 20705

OFFICIAL BUSINESS

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF AGRICULTURE